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REPORT NO. 851

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THE ROLE OF AUTOMATED BLOOD GROUPING AS AN INFORMATION RETRIEVAL SYSTEM

(Progress Report)

by

LTC Frank R. Camp, Jr., MSC

and

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16 February 1970

UNITED STATES ARMY
MEDICAL RESEARCH AND DEVELOPMENT COMMAND

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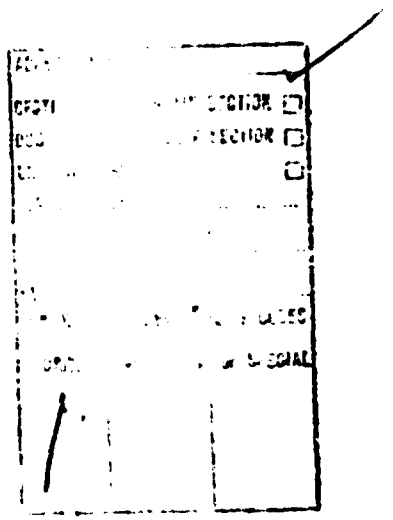

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THE ROLE OF AUTOMATED BLOOD GROUPING AS AN INFORMATION RETRIEVAL SYSTEM

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Blood Transfusion Division
US ARMY MEDICAL RESEARCH LABORATORY
Fort Knox, Kentucky 40121

16 February 1970

Evaluation of Blood Banking Methods
and Transfusion Practices
Work Unit No. 176
Combat Surgery
Task No. 00
Combat Surgery
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ABSTRACT

THE ROLE OF AUTOMATED BLOOD GROUPING
AS AN INFORMATION RETRIEVAL SYSTEM

OBJECTIVE

To develop a master data retrieval system for use in identification.

METHODS

Improved methodology to perform blood grouping employing the AutoAnalyzer system was used in the study.

RESULTS AND CONCLUSIONS

The role of the human blood groups is used as the common denominator in a reliable identification program. A master plan is considered with details for its present-day requirement and methodology to implement an information retrieval system.

THE ROLE OF AUTOMATED BLOOD GROUPING AS AN INFORMATION RETRIEVAL SYSTEM

INTRODUCTION

The use of the human blood groups remains as an important method of individual identification. Complicating events in both the civilian and military communities require continuing development and refinement of identification technics, such that erroneous conclusions are reduced to a minimum. The challenge facing numerous authorities responsible for employing identification technics is that of obtaining proper verification of their findings. Resolution of this requirement resides in the availability of an accurate information retrieval system. Consideration of various facets of a system will be described in this report.

HISTORICAL BACKGROUND (6)

It may not be generally and fully appreciated that the Armed Services played a unique role in the standardization of nomenclature used for the human blood groups in the United States. Prior to this development, civilian and military hospital laboratories were employing three systems of blood group nomenclature. These were the Jansky, the Moss, and the International ABO system of Landsteiner.

BLOOD TYPING OF MILITARY PERSONNEL

Major General (Ret) Douglas B. Kendrick (presently Director, Grady Memorial Hospital, Atlanta, Georgia) pointed out, after considerable discussion, the wisdom of, and necessity for, the blood typing of military personnel, and issued instructions for this action in War Department Circular No. 125, 24 June 1941, by the addition of changes in Army Regulation (AR) 40-1715, 15 August 1932, and AR 600-40, 22 June 1931, as follows:

AR 40-1715 - Paragraph 7 was added as follows:

"Determination and recording of blood types of all military personnel.--The blood group of each individual on active duty in the military service will be determined, using the International (or Landsteiner) classification. The proper performance of the tests in each organization will be a responsibility of the surgeon. The results will be recorded, using the symbols 'A', 'B', 'AB', or 'O', as indicated."

SUPPLEMENTAL INSTRUCTIONS

Because the brief experience with military blood typing revealed difficulties and errors, Circular Letter No. 88 (4 Sep 1941) was issued to control variations in technic and preparations of reagents, as well as the amount of sera to be used in the test. An additional letter, No. 112 (26 Nov 1941), clearly stated the objective of blood typing military personnel: ". . . to make possible the calling of voluntary donors

of a specific blood type and securing them on very short notice." In this same letter the point was made that there was a definite possibility of errors in mass blood grouping; however, crossmatching was to be done before transfusion and such errors would be recognized. However, this precaution was not to be taken as a reason for relaxing efforts to be absolutely accurate in the initial testing and recording. Additional changes in technic were suggested and unsatisfactory sera were to be reported to the Army Medical School to determine if this was a reagent or technical error. Further clarification on these procedures was reported in Letter No. 170 (2 Dec 1942).

In spite of errors in the laboratory, the blood grouping program was highly practical. If 100 group O donors were desired, only men whose identification tags were so marked would report. The chances were that, after retyping, 85 to 90 would prove to be group O. Without the preliminary screening, it would have been necessary to call at least 200 prospective donors to find approximately 100 group O donors.

Necessary as it was, the blood grouping program was one more thing to interfere with the training of troops. Many installations, therefore, devised their own methods of expediting the procedure. In some, unfortunately, the haste led to confusion and the confusion led to errors, a certain proportion of which could unquestionably be explained in this way. In other installations, the shortcuts were really efficient.

A control study was developed by Dr. E. I. DeGowin in June 1942, in which blood groups of cadets at the US Naval Preflight School in Iowa City were checked by two workers independently, in lots of 40-93 specimens. Both technicians used a technic proposed by Dr. DeGowin who served as one of the technicians and a well-trained pharmacist mate was the other. The total study involved 3,876 samples. In 24 tests, the errors could not be assigned because there was no opportunity to check the bloods involved. Otherwise, one worker made 40 errors (1%) and the other 110 (2.8%). Their report suggested that none of the errors could have been detected except by comparison of the results of two independent tests on the same blood. An analysis of the errors indicated more errors occurred when larger numbers of blood samples were examined. Mechanical errors in technic were also found in which working habits of the particular technician were responsible. Slide and centrifuge technics were of equal accuracy and the centrifuge technic was faster for single examinations, but not for mass typing because of the time needed to manipulate the tubes and centrifuge, and requiring more glassware and more glassware cleaning time. Though there were errors in transcription and in reading the results, those due to defective or weak sera were not revealed. In addition, elementary clerical errors in the initial labeling of a sample and subsequent mistakes in transcribing results to official documents were not considered.

In view of the errors made in this controlled study by a skilled physician and an extremely skilled worker, it was alarming to consider

the percentage of errors that probably had been made in the mass typing performed on Army and Navy personnel. By this time (March 1943), there must have been, by conservative estimate, at least 100,000 men in the Army alone who were erroneously typed. The situation was not dangerous if all medical officers who gave transfusions clearly understood that the blood type stamped on the identification tag was simply tentative. However, under pressure of an emergency, it was feared that some might omit crossmatching.

Subsequently, such error incidence was reported by many organizations; for example, on 4 March 1943, Major General Paul R. Hawley was informed of grouping errors of 6% reported in the 10th Station Hospital, then in Northern Ireland. This led to checks in other medical facilities and after examining a total of 2,340 bloods, 154 were found incorrectly typed. In addition, 179 patients lacked identification tags, and 33 had no record of their blood group. This total of 366 unsatisfactory findings indicated a 14.3% error incidence (6).

The 5- to 10-percent error in blood grouping was unfortunate and undesirable, but it might have been expected for a number of reasons: the lack of avidity of typing sera; the utilization of antibody from rabbit serum that was not always as specific as it should have been; and the inexperience of the personnel who did the typing. One source of error has already been intimated--the fact that in many camps and posts during World War II, through a mistaken sense of values, personnel responsible for mass typing placed high on their priority list the speed with which the typing was done. Speed led to confusion, and confusion produced errors, further compounded by the lack of experience of those doing the typing.

THE CURRENT PROBLEM

Since 1941, the ABO blood group of all US Army personnel has been recorded on identification tags and medical records. The method used has been the standard test tube or slide technic, even though these methods have recognized technical pitfalls and clerical errors. In an effort to improve the system and accuracy, Army Regulation 40-3, Change 14 (3 Feb 1967), established that blood group determination would be carried out on red blood cells which would be confirmed by serum grouping, and would include the Rh type. The blood group processing was to be carried out by the organization initially receiving the man on duty. This involves post surgeons and reception centers.

Several problems are evident in the new requirement. Not only are additional tests required, but the tests are complex and require experienced personnel and well-controlled reagents. Once these tests are performed, the clerical transfer to official records will also be subject to increased error. In fact, a recent study identifying the various sources of error has shown a 3-5% error of purely clerical nature (9).

Usefulness of these tests can be expanded in supporting mass identification in four major areas if sufficient accuracy can be technically established:

1. Reliable Basis for Treatment.

In the multiple-transfused combat casualty, blood groups may be difficult to ascertain, when group O, universal donor, blood has been recently administered. Other factors are rouleaux formation from dextran therapy and new antibody production which complicates serum studies. Eventual return to the original genetic blood group in future treatment by blood transfusion therapy is significantly enhanced when identification tags, medical records, and/or referral to a data retrieval system provide correct information. This requirement exists in military, Veterans Administration, and civilian hospitals receiving multiple-transfused combat casualties.

2. Reliable Identification of Combat Casualty Remains.

In combat situations, positive identification of the dead achieves an important priority. The philosophy and technic of body identification at large mortuaries in the combat zone become a challenge when one must cope with the fact that the remains are, indeed, not always intact. The identification of extremely mangled, burned, or blasted bodies requires the use of a number of separate pieces of evidence. When a series of separate pieces of evidence all add up to the same conclusion, the identification becomes more dependable or reliable. In the case of identification tags and medical records, errors in the present system downgrade this area as a reliable reference source. The need for accurate blood group information in the combat zone cannot be overemphasized. The need is for *in situ* identification at combat mortuaries from accurate blood group information on identification tags, medical records, and/or referral to a data retrieval system.

3. Medical-Legal Reference.

The role of mass identification from accurate blood grouping is related to medical-legal problems and their resolution. Cases of rape, murder, and other forensic problems can be better resolved when existing evidence (blood, blood crusts, and blood stains) is *supported* by accurate identification tags and medical records, or further *verified* by referral to a data retrieval system.

4. Mass Donor Screen and Repository.

A fourth application of the mass identification process, being described in this report, is one which we will entitle the mass donor screen. It is not placed fourth in sequence because it is the least important, but rather that it fits in here as a *keystone to the other three important facets.* All facets rely on the same factor--complete

accuracy of the blood group placed on the identification tag and medical records. It may be said that the data retrieval system referral unit is the repository for the reliable data of all military personnel concerning basic blood groups, subgroups, universal donors, and rare blood groups to compose a rare donor file. To simplify the discussion to follow, we will refer to the repository of blood group data on all military personnel as the Central File. The use of such data can also be made available to geneticists, immunoanthropologists, and other scientists.

THE NEED FOR CORRECTION OF ERRORS--A SERIOUS ENIGMA

There are several areas contributing to the problems inherent in present systems of identifying blood groups of military personnel.

One of these areas concerns the personnel who perform the testing, their competence or degree of training, and finally, the technic or technics (methodology) employed. The factor of standardization is implicated in both aspects of this problem area.

Another province for concern is the availability of suitable reagents and *their proper use*. The titer, avidity, and specificity of blood grouping reagents, supplied to the military as standard items, have required specifications which meet the highest criteria for safe blood grouping and blood typing. This includes anti-A, anti-B, group O, anti-Rh_0, anti-human globulin (Coombs) serum and 30% bovine albumin. The quality control of these reagents is rigidly monitored by the Blood Transfusion Division, US Army Medical Research Laboratory, Fort Knox, Kentucky, the Defense Personnel Support Center, and the Defense Medical Materiel Board. The use of proper erythrocytes in confirming the blood group by serum testing is in the hands of each laboratory performing such tests. It is here that some breakdown occurs in selection and/or availability of *red cells that are truly* A_1 *and* B. Training and individual competence of technicians applies here equally as they do in the first area of concern (1).

Finally, clerical error permeates the present system of manual testing and is probably the leading cause for the appearance of the wrong blood group and/or blood type on the identification tag and medical record. There is an *interaction of events* that occurs in the implementing of AR 40-3, which is intended to provide more accurate records or recording of blood group data. These include: training; standardization; methodology; and availability and use of improved manual, semiautomated, and fully automated technics. More adequately stated--the need exists for systems to achieve improved methodology, including the final transposition of blood group serology data onto identification tags and medical records, without error. This is the ultimate goal of our efforts which also would make this *accurate blood group data* constantly and immediately available to all agencies requiring it from a *Central File repository*.

PROPOSED MASTER PLAN

Various studies have been undertaken to evaluate manual, semi-automated, and fully automated systems available during 1966-1969 (2-9). Other systems are under consideration especially in the fully automated area. In addition to reporting the results of these studies, the gradual phase in of a master plan via a pilot study will be described (Fig. 1).

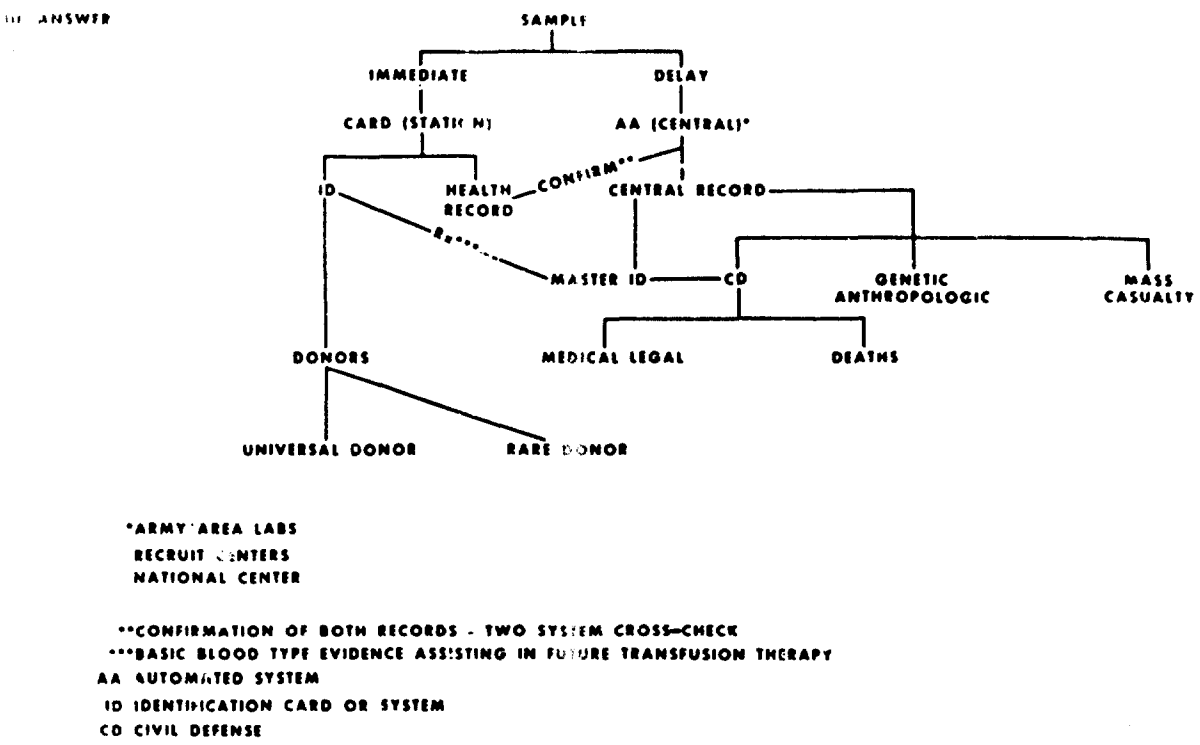

Fig. 1. Schema for utilizing the human blood groups in a retrieval system designed to meet civilian and military requirements.

A simplification or straight flow system of testing can be considered the optimum route in achieving maximum accuracy for the greatest number of individuals. Such accuracy must be coupled with easy data retrievability to provide the maximum flexibility. The simplicity of the automated system tested in the present study holds forth great potential in the area of accuracy but must be considered insufficient to meet the needs of data retrieval. It would be possible to consider a sophisticated system in which the blood sample of the individual would enter an automated chain from start to print-out finish in the specific individual's records. Such a system would provide an easy source for many records of various potential needs. From the military service point of view, this would supply a permanent master identification record which could be used to

supply the individual, whether in the military or a civilian, with his own personal identification. The master record would also be a potential source for rare donor identification, as well as supplying various genetic and anthropological data. By providing a central source of identification in case of mass casualty, whether from military or civil defense actions, or involving individual violence, many of the medical-legal problems of identification would be eased.

Because of the absence of a reliable data retrieval system in the present automated instrument, the clerical error involved in mass blood grouping has yet to be eliminated. The data can be processed by manual effort, but this increases the time required to process the test results and record them in appropriate records. As an interim program to accomplish more accurate mass blood grouping, the following is considered.

The individual sample is drawn and immediately tested on a dried reagent card which provides an immediate permanent record, at the local level. This can be used to provide immediate information for the health record and preparation of identification tag. The rest of the properly labeled sample is shipped to a central laboratory for testing by the automated method. Results from this central agency can be entered into a Central File, as well as being a source for confirming the original card blood group test. Because the card test is a permanent record, whatever difference is found between the card and the automated method can be compared on repeat testing and the discrepancy resolved.

The present study has shown the automated method to have the greatest potential for multiple tests with the greatest accuracy but, unfortunately, does not yet have the means to transfer the results to medical records (5). In addition, it has a high initial cost and requires extensive training of the technical staff. However, this can be partially compensated by concentrating the machine and staff to a few central areas, such as Army area laboratories or reception stations, and having the blood shipped to these areas, providing a steady flow of samples which will feed the automated system at a maximum capacity. The card test expands upon the original slide method by including the Rh test and a control, as well as supplying a permanent record which is immediately available for administrative use. Being backed up by the automated system, particularly with serum grouping, what few errors do occur will be amenable to correction. The experience of this study has shown the card test to be almost as simple and as fast as the slide test, but at some additional cost (8).

SUMMARY

Classic mass blood grouping technics have been tested using the standard tube test, the direct reagent card, and the automated method. With the standard tube test as a control, the slide method, limited to the ABO system, had the highest number of errors. In contrast, the automated method was essentially without error in the ABO and Rh systems,

while the dried reagent card had only occasional error in the ABO system and somewhat higher error in the Rh system, relating to a lower reactivity of this antiserum with red cells.

In an effort to meet the needs of the new regulation for identifying the Rh, as well as the ABO system, various proposals were made. The ideal system would appear to be a fully automated program from sample to recording of the results on the record and input of this data from reception centers to the central record file. Unfortunately, this is not available yet and manual recording of the data must be continued.

As an interim expedient, the use of the reagent card in place of a slide method accomplishes the Rh identification and also provides a permanent record. Along with this, the sample is also tested in the automated system which provides a second system of confirmation, as well as being a source for a central record file.

Continuing studies are designed to ascertain cost of other factors in automating blood grouping *at* and *between* reception centers. This includes air delivery of specimens to another post from the standpoint of time, condition of blood sample, and final input of results onto pertinent medical records and identification tags. Hopefully, the results of feasibility testing of an efficient, moderately priced, fully automated system would bypass the less desirable reagent card interim expedient.

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13. ABSTRACT

The role of the human blood groups is used as the common denominator in a reliable identification program. A master plan is considered with details for its present-day requirement and methodology to implement an information retrieval system.

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